Social network analysis – Investigation of agonistic behaviour in pig production

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Session 54, abstract number 18641, kbuettner@tierzucht.uni-kiel.de
• **Mixing of unacquainted animals** is a standard procedure in commercial pig production
  → Unstable social structures
  → Increased agonistic interactions in order to establish a new rank order

• **Agonistic interactions** negatively influence
  → Animal health
  → Animal welfare
  → Production parameters
• **Network analysis**
  → Characterization of the structures of social relationships
  → Knowledge about formation and development of behavioural patterns

• **Network view of agonistic interactions**
  → Nodes: Individual animals
  → Edges: Agonistic interactions
• **Network analysis**
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• **Network view of agonistic interactions**
  → Nodes: Individual animals
  → Edges: Agonistic interactions

• **Aim of the study**
  → Development of the network parameters over three different age levels
  → Impact of the network position in previous rehousing and mixing situations?
Video observation

- **Observation period**: December 2010 to August 2012

- **Research farm “Hohenschulen“** (Institute of Animal Breeding and Husbandry, Christian-Albrechts-University, Kiel)

- Record of **agonistic interactions** of pigs in three different age levels

  ![Wean, grow, gilt diagram]

- The video observation started **directly after rehousing and mixing** for two days
  → **7,020 agonistic interactions** between **1,354 animals**
  → **149 animals** were tracked the whole period from weaned pig to gilt
Agonistic interactions

• Definition of an agonistic interaction
  
  – **Start:** Physical contact of one animal towards another (> 1 sec)
    
    Examples: Head to head knocks, head to body knocks, parallel or inverse pressings, biting

  – **End:** Submissive behaviour of an involved animal
    
    Examples: Turning away, displacement from a location, fleeing

Jensen (1980)
• **Centrality parameters**
  → Node level
  → Description of the individuals’ position in the network
  → “Which are the most central or important nodes in the network?“

• **General network properties**
  → Network level
  → Description of the whole network structure
  → Comparison between different networks
Centrality parameters

- **Degree centrality**
  - Unweighted: Number of opponents
  - Weighted: Number of fights

- **In-degree centrality**
  - Unweighted: Number of attackers
  - Weighted: Number of received fights

- **Out-degree centrality**
  - Unweighted: Number of attacked opponents
  - Weighted: Number of initiated fights
Centrality parameters

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Social network analysis

General network properties

• **Density**
  → Proportion of all present edges in comparison to the number of all possible edges (Range: 0 to 1)

• **Clustering coefficient**
  → Extent two opponents of an animal are opponents themselves (Range: 0 to 1)

• **Degree assortativity**
  → The tendency of an animal to fight preferably with other animals which have a similar degree compared to their own (Range: -1 to 1)
### Centrality parameters

#### Median number (range) of animals and fights in each age level

<table>
<thead>
<tr>
<th></th>
<th>Weaned pigs</th>
<th>Growing pigs</th>
<th>Gilts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals / Pen</td>
<td>9 (6 - 11)</td>
<td>23 (20 - 25)</td>
<td>24 (18 - 29)</td>
</tr>
<tr>
<td>Fights / Pen</td>
<td>52 (18 - 280)</td>
<td>80 (44 - 120)</td>
<td>68 (38 - 118)</td>
</tr>
</tbody>
</table>

**Degree**

- **Opponents / Animal (unweighted)**
  - Weaned pigs: 7 (0 - 16)
  - Growing pigs: 5 (1 - 18)
  - Gilts: 5 (0 - 22)

- **Fights / Animal (weighted)**
  - Weaned pigs: 12 (0 - 96)
  - Growing pigs: 5 (1 - 27)
  - Gilts: 5 (0 - 36)

**In-degree**

- **Attackers / Animal (unweighted)**
  - Weaned pigs: 4 (0 - 8)
  - Growing pigs: 3 (0 - 11)
  - Gilts: 3 (0 - 11)

- **Received fights / Animal (weighted)**
  - Weaned pigs: 7 (0 - 51)
  - Growing pigs: 3 (0 - 16)
  - Gilts: 3 (0 – 17)

**Out-degree**

- **Victims / Animal (unweighted)**
  - Weaned pigs: 3 (0 - 9)
  - Growing pigs: 2 (0 - 10)
  - Gilts: 2 (0 - 16)

- **Initiated fights / Animal (weighted)**
  - Weaned pigs: 5 (0 - 73)
  - Growing pigs: 3 (0 - 17)
  - Gilts: 2 (0 - 29)
Spearman rank correlation coefficients between in-degree and out-degree in three different age levels

<table>
<thead>
<tr>
<th>Centrality parameter</th>
<th>Weaned pigs</th>
<th>Growing pigs</th>
<th>Gilts</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-degree – out-degree</td>
<td>0.70*</td>
<td>0.48*</td>
<td>0.61*</td>
</tr>
</tbody>
</table>

*p < 0.05

Spearman rank correlations of the centrality parameters between the age levels

<table>
<thead>
<tr>
<th>Centrality parameter</th>
<th>Weaned pigs - growing pigs</th>
<th>Growing pigs - gilts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>0.19*</td>
<td>0.19*</td>
</tr>
<tr>
<td>In-degree</td>
<td>-0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>Out-degree</td>
<td>0.27*</td>
<td>0.25*</td>
</tr>
</tbody>
</table>

*p < 0.05
Median number (range) of the general network properties density, clustering coefficient and degree assortativity in each age level

<table>
<thead>
<tr>
<th></th>
<th>Weaned pigs 0.45 (0.24 - 0.94)</th>
<th>Growing pigs 0.13 (0.07 - 0.17)</th>
<th>Gilts 0.12 (0.06 - 0.25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.75 (0.29 - 1)</td>
<td>0.32 (0.14 - 0.50)</td>
<td>0.22 (0.05 - 0.56)</td>
</tr>
<tr>
<td>Clustering coefficient</td>
<td>-0.25 (-0.78 - 0.15)</td>
<td>-0.10 (-0.37 - 0.24)</td>
<td>-0.19 (-0.34 - 0.14)</td>
</tr>
<tr>
<td>Degree assortativity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Centrality parameters

- Decrease of agonistic interactions with higher age level
  - Habituation effect
  - Development of new coping strategies

- Lower correlation coefficients between in-degree and out-degree in growing pigs and gilts
  - More stable network position due to their increased familiarity and their experiences acquired from previous agonistic interactions

- Correlations between the out-degree over the three different age levels showed more stable results
  - Out-degree describes an active behaviour
  - In-degree depends on the aggression of the pen mates
General network properties

- **Decrease of density and clustering coefficient in older age levels**
  - Learning process from previous fighting situations
  - Gained confidence acquired by previous success

- **Negative degree assortativity in all three age levels**
  - Networks with a negative connotation show a smaller reciprocity than networks with a positive connotation (e.g. grooming, affiliation)
General network properties

• Decrease of density and clustering coefficient in older age levels
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• Network analysis
  → Characterization of individual position in agonistic interaction networks
  → Development of network parameters over different age levels
  → New insights in the formation and evolution of behavioural patterns
Thank you for your attention!